Sickly shades of gray: Disease outbreaks influence the color of wolves across North America

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Members of the Druid Peak Pack in Yellowstone National Park engage in a game of chase. The gray colored wolf on the left represents the homozygous gray phenotype, while the black colored wolf on the right represents the K-locus black

phenotype. Credit: Daniel Stahler/NPS

New research from the University of Oxford, Yellowstone National Park, and Penn State, published today in the journal *Science*, may have finally solved why wolves change color across the North American continent.

If you were to travel from Arctic Canada and head south down the Rocky Mountains into the U.S. toward Mexico, the further south you go, the more black wolves there are. The reasons why have long puzzled scientists.

Professor Tim Coulson from the Department of Biology, University of Oxford who led the work explains, "In most parts of the world black wolves are absent or very rare, yet in North America they are common in some areas and absent in others. Scientists have long wondered why. We now have an explanation based on wolf surveys across North America, and modeling motivated by extraordinary data collected by co-authors who work in Yellowstone."

Coat color in wolves (Canis lupus) is determined by a gene called CPD103. Depending on the variant of the gene a wolf has, its coat can either be black or gray.

The researchers postulated that this gene also plays a role in protecting against respiratory diseases such as canine distemper virus (CDV). This is because the DNA region containing the gene also encodes for a protein that plays a role in defending against infections in the lungs of mammals. They predicted that having a black coat would be associated with the ability of wolves to survive an infection with CDV.

About half black and half gray, members of the Druid Peak Pack gather to howl at a neighboring wolf pack. Credit: Daniel Stahler/NPS

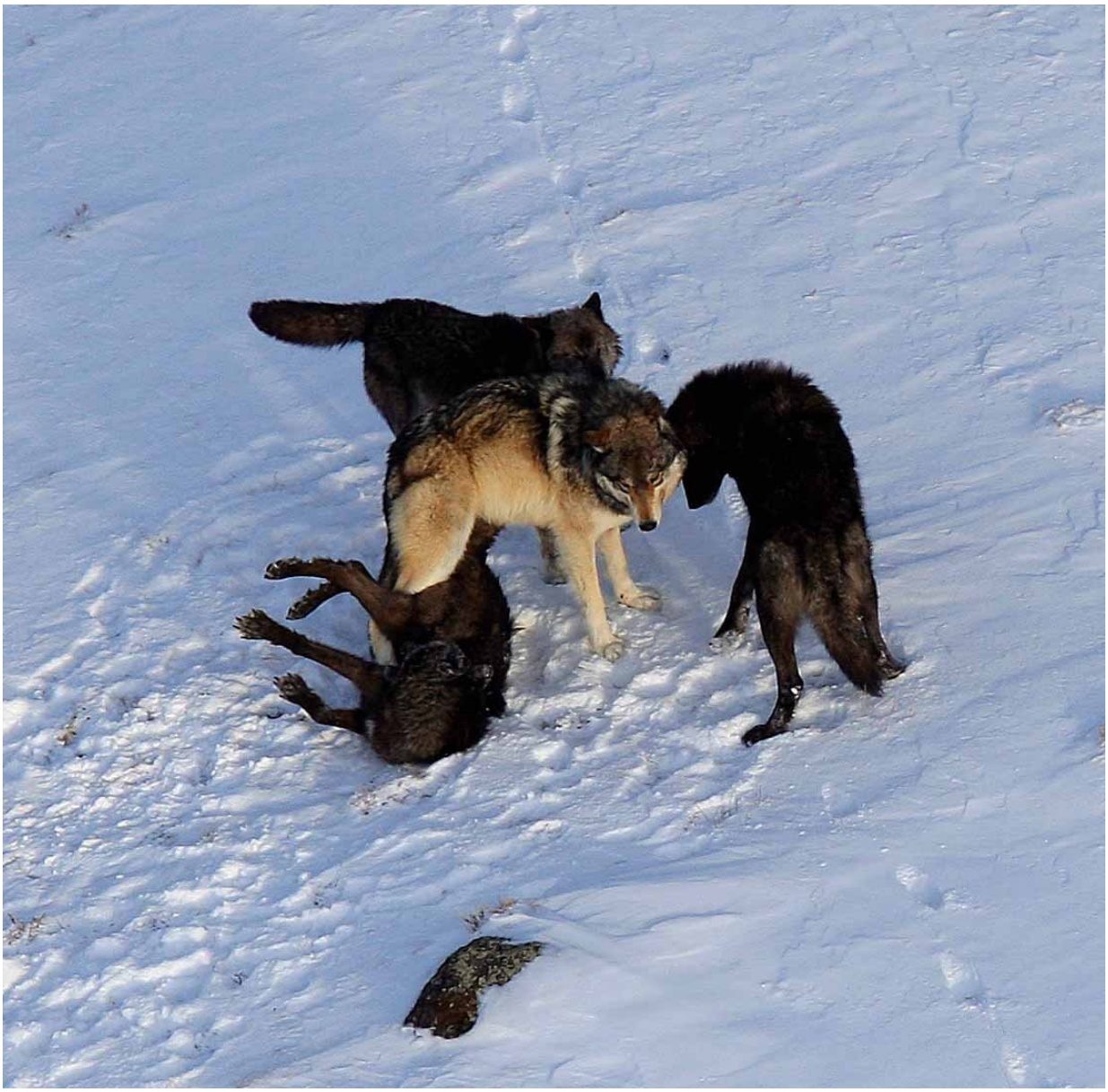
To test this idea, they analyzed 12 wolf populations from North America, to examine whether the probability of a wolf being black was predicted by the presence of CDV antibodies. If a wolf has CDV antibodies, then it has caught CDV in the past and survived. They found that wolves with CDV antibodies were more likely to be black than gray. They also found that black wolves were more common in areas where

CDV outbreaks occurred.

The researchers analyzed over 20 years-worth of data from the wolf population at Yellowstone National Park. They found that black wolves were more likely to survive CDV outbreaks compared with gray wolves. These results led them to hypothesize that in areas where distemper outbreaks occur wolves should choose mates of the opposite coat color to maximize the chance their cubs would have black coats.

They used a simple mathematical model to test this idea. Excitingly, the predictions from their model closely matched the observations that black and gray wolves were more likely to pair in areas where CDV outbreaks are common. This competitive advantage is lost in areas where CDV outbreaks do not occur.

These results are consistent with the idea that the frequency of CDV outbreaks across North America is responsible for the distribution of black wolves, because having the gene for a black coat may also provide protection against the virus. It also explains why mating pairs in Yellowstone, where canine distemper outbreaks occur, tend to be black-gray.



A gray male and black female are locked into a copulatory tie while other packmates gather around, demonstrating disassortative mate choice based on coat color. Credit: Daniel Stahler/NPS

Peter Hudson, Willaman Professor of Biology, Penn State, said, "It's intriguing that the gene for protection against CDV came from domestic

dogs brought by the first humans entering North America, and the CDV disease virus emerged in North America many thousands of years later, once again from dogs."

"What I love about this study is how we have been able to bring together experts from so many fields and a range of approaches to show how disease can have remarkable impacts on wolf morphology and behavior. We are learning that disease is a major evolutionary driver that impacts so many aspect aspects of animal populations."

The researchers speculate that other species may follow a similar pattern to wolves. Many insects, amphibians, birds and nonhuman mammals have associations between color and disease resistance. It might be that the presence a disease, or how frequently a disease outbreak occurs, is an important factor affecting the color of mate an animal prefers.

More information: Sarah Cubaynes, Distemper outbreaks select for mate choice and coat color in wolves, *Science* (2022). DOI: 10.1126/science.abi8745. www.science.org/doi/10.1126/science.abi8745

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